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NEW SPECIES OF *CLOACINA* LINSTOW, 1898 (NEMATODA: STRONGYLOIDEA) PARASITIC IN THE STOMACH OF THE QUOKKA, *SETONIX BRACHYURUS* (MARSUPIALIA : MACROPODIDAE), FROM WESTERN AUSTRALIA

by I. BEVERIDGE[1]

Summary

BEVERIDGE, I. (1999) New species of *Cloacina* Linstow, 1898 (Nematoda : Strongyloidea) parasitic in the stomach of the quokka, *Setonix brachyurus* (Marsupialia : Macropodidae), from Western Australia. *Trans. R. Soc. S. Aust.* **123**(1), 17-30, 31 May, 1999.

Six new species of *Cloacina* Linstow, 1898 are described from the stomach of the quokka, *Setonix brachyurus*, from Rottnest Is., Western Australia. They are: *C. ceres* sp. nov., characterised by lip-like inflations of the peri-oral cuticle, oesophageal bosses extending two thirds of the way to the nerve ring, the deirid posterior to the nerve ring, absence of oesophageal denticles, a symmetrical buccal capsule, a simple straight vagina and spicules 1.56-1.97 mm in length; *C. laius* sp. nov., characterised by a dorsoventrally elongated buccal capsule, six leaf crown elements, a shallow buccal capsule which is arched anteriorly in lateral views, oesophageal bosses extending to the nerve ring, a single dorsal oesophageal denticle, spicules 1.50-1.97 mm in length and a recurrent vagina; *C. circe* sp. nov., characterised by a dorsoventrally elongated mouth opening, six leaf crown elements, cephalic papillae which are situated close together and whose tips are deviated medially, a shallow buccal capsule arched anteriorly, an oesophagus without bosses or denticles, the deirid posterior to the nerve ring, spicules in the range 0.97-1.35 mm and a straight vagina; *C. chiron* sp. nov., characterised by a cervical cuticular inflation, cephalic papillae with a long, obtuse distal segment, six leaf crown elements, a symmetrical buccal capsule, a simple oesophagus without denticles or bosses, spicules in the range 0.58-0.65 mm and a straight vagina; *C. cadmus* sp. nov., characterised by its small size, simple slender oesophagus lacking bosses or denticles, small, symmetrical buccal capsule, cephalic papillae with the proximal segment longer than the distal, six leaf crown elements, spicules in the range 1.31-1.46 mm and a straight vagina; *C. telemachus* sp. nov., characterised by the shape of the cephalic papillae with the distal segment globose and directed medially, six leaf crown elements, an oesophagus without bosses or denticles, the deirid posterior to the nerve ring, spicules 2.35 mm long and a straight vagina.

KEY WORDS: *Cloacina*, new species, nematodes, *Setonix*, quokka, marsupials, parasites.

Introduction

Many species of macropodid marsupials are parasitised by a suite of species of the nematode genus *Cloacina* Linstow, 1898 occurring in the sacculated forestomachs of their hosts. The number of species of *Cloacina* known from different kangaroo or wallaby hosts which have been examined in detail varies considerably, ranging from none in the case of the red-necked wallaby, *Macropus rufogriseus banksianus* (Quoy & Gaimard, 1825) or two in the case of the Tasmanian pademelon, *Thylogale billardierii* (Desmarest, 1822), to 25 in the case of the wallaroo or euro, *Macropus robustus* Gould, 1841 based on a recent revision of the genus (Beveridge 1998). In other macropodid species, insufficient numbers of hosts have been examined for parasites to be able to provide reliable estimates of the diversity of species of *Cloacina* likely to be encountered in them. One such host species is the quokka, *Setonix brachyurus* (Quoy & Gaimard, 1830), which is limited in its distribution to the southwestern region of Western Australia (Kitchener 1995). A single species of *Cloacina*, *C. setonicis* was described from this host by Mawson (1961) and has subsequently been redescribed by Beveridge (1998), but since this was based on a single collection, it is possible that additional species exist. Examination of a series of quokkas has indicated that they, like most other macropodids, are parasitised by a series of species of *Cloacina*. The new species encountered are described in this paper.

Materials and Methods

A series of six quokkas was collected on Rottnest Is., WA in April 1982, using hand nets. The animals were killed with an overdose of sodium pentabarbitone and the stomach was examined for parasitic nematodes. Nematodes found were fixed in hot 70% ethanol and were subsequently stored in 70% ethanol with 5% glycerol. For examination, nematodes were cleared in lactophenol. Permanent

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[1] Department of Veterinary Science, The University of Melbourne Parkville Vic. 3052.

preparations on slides of apical views of the mouth opening, the bursa and the spicule tips were made using polyvinyl lactophenol as the mounting medium.

Drawings were prepared using an Olympus BH2 microscope with Nomarski interference optics and a drawing tube. Measurements were made using an ocular micrometer and are presented in the text in millimetres as the range followed in parentheses by the mean. Drawings of apical views of the mouth opening are presented with the dorsal aspect uppermost; drawings of the bursa have the ventral lobes uppermost.

Holotypes have been deposited in the South Australian Museum, Adelaide (SAMA). Paratypes have been deposited in SAMA and in the British Museum (Natural History), London (BMNH).

Morphological terminology for nematodes follows that used by Beveridge (1998). The abbreviated term S-E pore is used in place of secretory-excretory pore (Bird & Bird 1991) and oesophagus is used as a synonym of the more correct term "pharynx" (Bird & Bird 1991).

Following Beveridge (1998), the new species are based on classical names since the generic name is that of a Roman goddess.

Cloacina ceres sp. nov.
(FIGS 1-14)

Types. Holotype ♂, from stomach of *Setonix brachyurus*, Rottnest Is., WA, coll. I. Beveridge, 7.iv.1982, SAMA AHC 30558; allotype ♀, SAMA AHC 30559; paratypes: 15 ♂♂, 60 ♀♀, SAMA AHC 30560; 1 ♂, 1 ♀, BMNH 1998.9.28.3-4.

Description

Small nematodes; cervical cuticle not inflated in oesophageal region; transverse cuticular annulations prominent. Sub-median papillae very small, 0.004 long, projecting anterolaterally from peri-oral cuticle, situated on elevations of peri-oral cuticle; proximal segment cylindrical, extremely short, 0.001 long, shorter than ovoid, obtuse distal segment, 0.003 long. Buccal capsule shallow, cylindrical, symmetrical in dorsoventral views, circular in apical view. Leaf crown elements 6 in number, with prominent striations, arising from full length of internal wall of buccal capsule, not recurved at tips. Peri-oral cuticle inflated into lip-like lobes attached to each leaf crown element. Dorsal tooth projecting prominently into buccal capsule; each subventral sector of oesophagus with lancet-like projection into buccal capsule. Oesophagus simple, claviform; lining ornamented with rows of sclerotised bosses from anterior end to two thirds of distance to nerve ring; denticles absent from oesophagus. Nerve ring in mid-oesophageal region; deirids in posterior oesophageal region, between nerve ring and S-E pore; S-E pore anterior to oesophago-intestinal junction.

Male (Measurements from 10 specimens, types) (Figs 9-12)

Total length 4.3-6.0 (5.4); maximum width 0.17-0.22 (0.18); dimensions of buccal capsule 0.010-0.015 (0.013) x 0.032-0.038 (0.035); length of oesophagus 0.36-0.48 (0.41); nerve ring to anterior end 0.19-0.26 (0.21); S-E pore to anterior end 0.32-0.43 (0.38); deirids to anterior end 0.32-0.40 (0.34). Bursa without prominent divisions between lobes. Ventral lobes joined ventrally; lateral lobes and ventral lobes joined. Dorsal lobe similar in length to lateral lobes. Dorsal ray divides at midlength; secondary subdivisions occur at $^{1}/_{4}$ length; internal branchlets directed posteriorly, not reaching margin of bursa; external branchlets shorter than internals, directed laterally, not reaching margin of bursa. Externodorsal ray arising close to lateral rays, not reaching margin of bursa. Posterolateral and ventrolateral rays fused, reaching margin of bursa; anterolateral ray divergent, shorter than other lateral rays, not reaching margin of bursa; ventrolateral and ventroventral rays fused, reaching margin of bursa. Gubernaculum broadly ovoid, 0.010-0.020 (0.013) long; genital cone with prominent anterior lip; posterior lip shorter than anterior lip, with pair of dome-shaped papillae; pair of lateral inflations of cuticle present on either side of anterior lip; spicules elongate, 1.56-1.97 (1.76) long, alate, tip simple; ala diminishing in width gradually towards tip.

Female (Measurements from 10 specimens, types) (Figs 13-14)

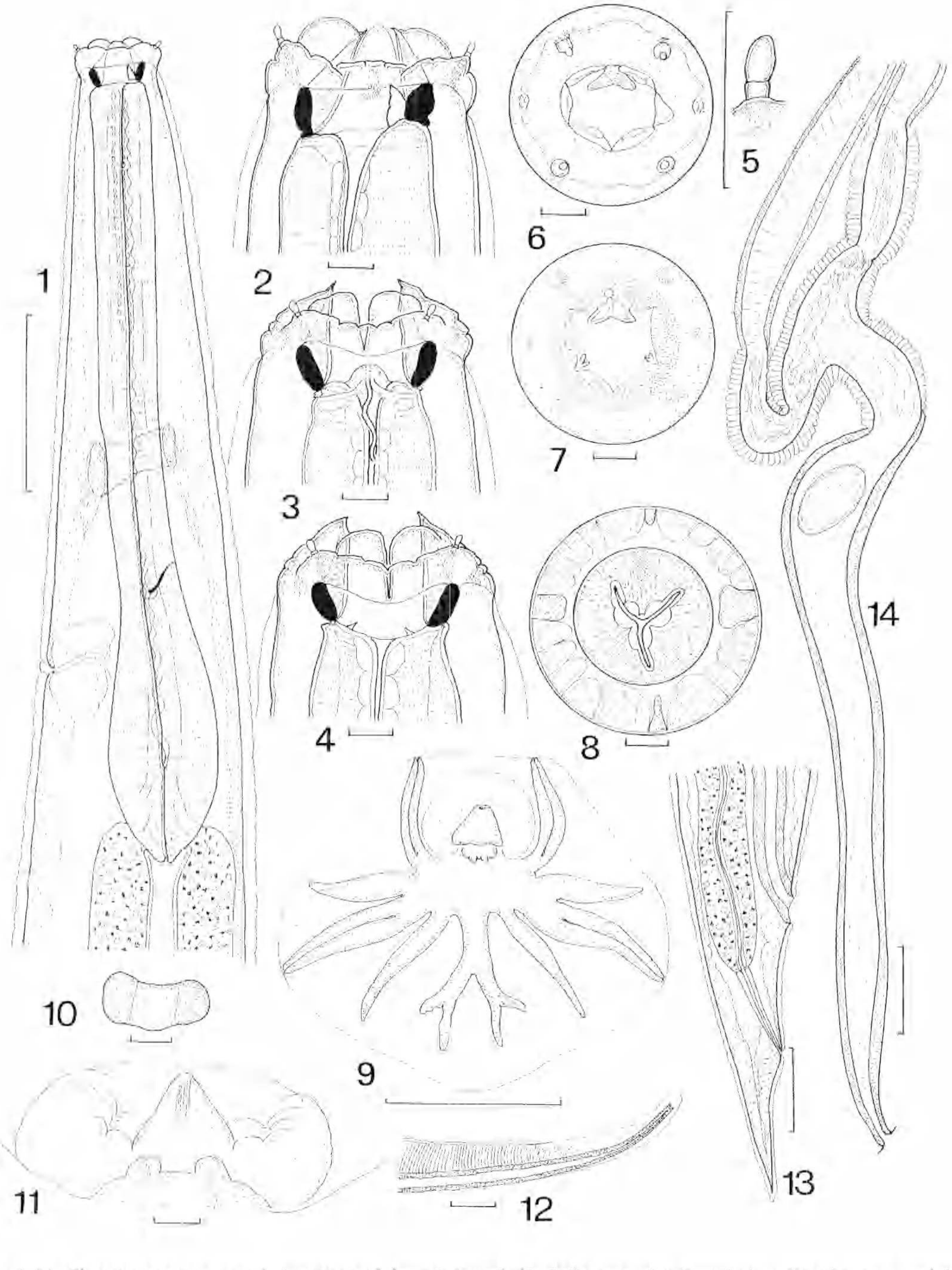
Total length 4.1-6.4 (5.7); maximum width 0.19-0.27 (0.24); dimensions of buccal capsule 0.010-0.015 (0.013) x 0.035-0.040 (0.039); length of oesophagus 0.41-0.44 (0.43); nerve ring to anterior end 0.18-0.22 (0.20); S-E pore to anterior end 0.30-0.40 (0.36); deirids to anterior end 0.25-0.35 (0.30). Tail simple, conical, 0.11-0.25 (0.16) long; vulva close to anus, 0.26-0.38 (0.33) from posterior end, vagina straight, 0.62-1.05 (0.91) long; ovejector J-shaped, infundibulum longer than sphincter; egg ellipsoidal, 0.08-0.10 (0.09) x 0.04-0.06 (0.05).

Etymology

Ceres, goddess of agriculture.

Remarks

Cloacina ceres is characterised by the presence of lip-like inflations of the peri-oral cuticle, oesophageal bosses extending $^{2}/_{3}$ of the way to the nerve ring, the deirid posterior to the nerve ring,



Figs 1-14. *Cloacina ceres* sp. nov. 1. Anterior end, lateral view. 2. Cephalic extremity, lateral view, dorsal aspect on right hand side. 3. Cephalic extremity, dorsal view. 4. Cephalic extremity, ventral view. 5. Cephalic papilla. 6. Cephalic extremity, apical view. 7. Cephalic extremity, transverse optical section through base of buccal capsule. 8. Transverse section through anterior extremity of oesophagus showing thickening of lining of oesophagus. 9. Bursa, apical view. 10. Gubernaculum, ventral view. 11. Genital cone, dorsal view. 12. Spicule tip, lateral view. 13. Female tail, lateral view. 14. Vagina and ovejector, lateral view. Scale bars = 0.1 mm, 1, 9, 13, 14; 0.01 mm, 2-8, 10-12.

absence of oesophageal denticles, a symmetrical buccal capsule, a simple straight vagina and spicules 1.56-1.97 mm in length. It is distinguishable from all congeners except *C. castor* Beveridge, 1979, *C. eos* Beveridge, 1998 and *C. papillata* Beveridge, 1979 by the possession of 6 rows of oesophageal bosses and the occurrence of the deirid posterior to the nerve ring. *Cloacina ceres* is distinguishable from all of these species by the shape of the cephalic papillae which have a very short proximal segment and a larger obtuse distal segment similar to that encountered in *C. dryope* Beveridge, 1998, *C. hebe* Beveridge, 1998, *C. hypsipyle* Beveridge, 1998, *C. linstowi* Johnston & Mawson, 1940, *C. maia* Beveridge, 1998 and *C. thetidis* Johnston & Mawson, 1939, a suite of species occurring in *Macropus dorsalis* (Gray, 1837) but lacking oesophageal bosses. *Cloacina ceres* is further distinguished from *C. castor*, *C. eos* and *C. papillata* by the presence of lip-like inflations of the circumoral cuticle and from *C. eos* and *C. papillata* in having a straight rather than a recurrent vagina.

Cloacina laius sp. nov.

(FIGS 15-28)

Types: Holotype ♂ from stomach of *Setonix brachyurus*, Rottnest Is., WA, coll. I. Beveridge, 17.iv.1982, SAMA AHC 30567, allotype ♀, SAMA AHC 30568; paratypes: 10 ♂♂, 31 ♀♀, SAMA AHC 30569; 1 ♂, 1 ♀, BMNH 1998.9.28.9-10.

Description

Small nematodes; cervical cuticle not inflated in oesophageal region; transverse cuticular annulations prominent. Sub-median papillae 0.0095 long, projecting anteriorly from peri-oral cuticle; proximal segment cylindrical, 0.006 long, longer than ovoid distal segment, 0.0035 long. Mouth opening dorsoventrally elongate. Buccal capsule shallow, symmetrical laterally, arcuate in lateral view, with apex of arch lateral; dorsal and ventral views arcuate with bases of arch dorsal and ventral. Buccal capsule walls circular in apical view. Leaf crown elements 6 in number, arise from full length of internal wall of buccal capsule, slightly incurved at tips. Peri-oral cuticle not inflated into lip-like lobes attached to each leaf crown element. Oesophagus simple, claviform, without preneural swelling; dorsal lobe of oesophagus projecting prominently into buccal capsule, bearing duct of dorsal oesophageal gland; lining of oesophagus ornamented with rows of sclerotised bosses extending from anterior end to level of nerve ring; single dorsal oesophageal denticle present immediately anterior to nerve ring. Nerve ring in mid-oesophageal region; deirids in mid oesophageal region, immediately anterior to nerve ring; S-E pore anterior to oesophago-intestinal junction.

Male (Measurements from 10 specimens, types) (Figs 23-26)

Total length 5.6-7.4 (6.4); maximum width 0.24-0.38 (0.31); buccal capsule 0.006 (0.006) x 0.055-0.068 (0.058); length of oesophagus 0.45-0.52 (0.47); nerve ring to anterior end 0.23-0.25 (0.24); S-E pore to anterior end 0.38-0.47 (0.41); deirid to anterior end 0.17-0.24 (0.20). Bursa without prominent divisions between lobes. Ventral lobes joined ventrally; lateral lobes and ventral lobes joined. Dorsal lobe similar in length to lateral lobes. Dorsal ray divides at $^1/_3$ length; second subdivision occurs at mid-length. Internal branchlets longer than externals, directed posterolaterally, almost reaching margin of bursa; external branchlets shorter, directed almost laterally, not reaching margin of bursa. Externodorsal ray arises close to lateral rays, not reaching margin of bursa. Posterolateral and ventrolateral rays fused, reaching margin of bursa; anterolateral ray divergent, shorter than other lateral rays; not reaching margin of bursa; ventrolateral and ventroventral rays fused, reaching margin of bursa. Gubernaculum elongate, ovoid in dorsoventral view, 0.010-0.020 (0.017) long; genital cone prominent; anterior lip conical, with single papilla at apex, posterior lip shorter than anterior lip, with pair of dome-shaped papillae; pair of lateral inflations of cuticle present on either side of anterior lip; spicules elongate, 1.50-1.97 (1.64) long, alate; alae diminishing gradually in width towards tip.

Female (Measurements from 10 specimens, types) (Figs 27-28)

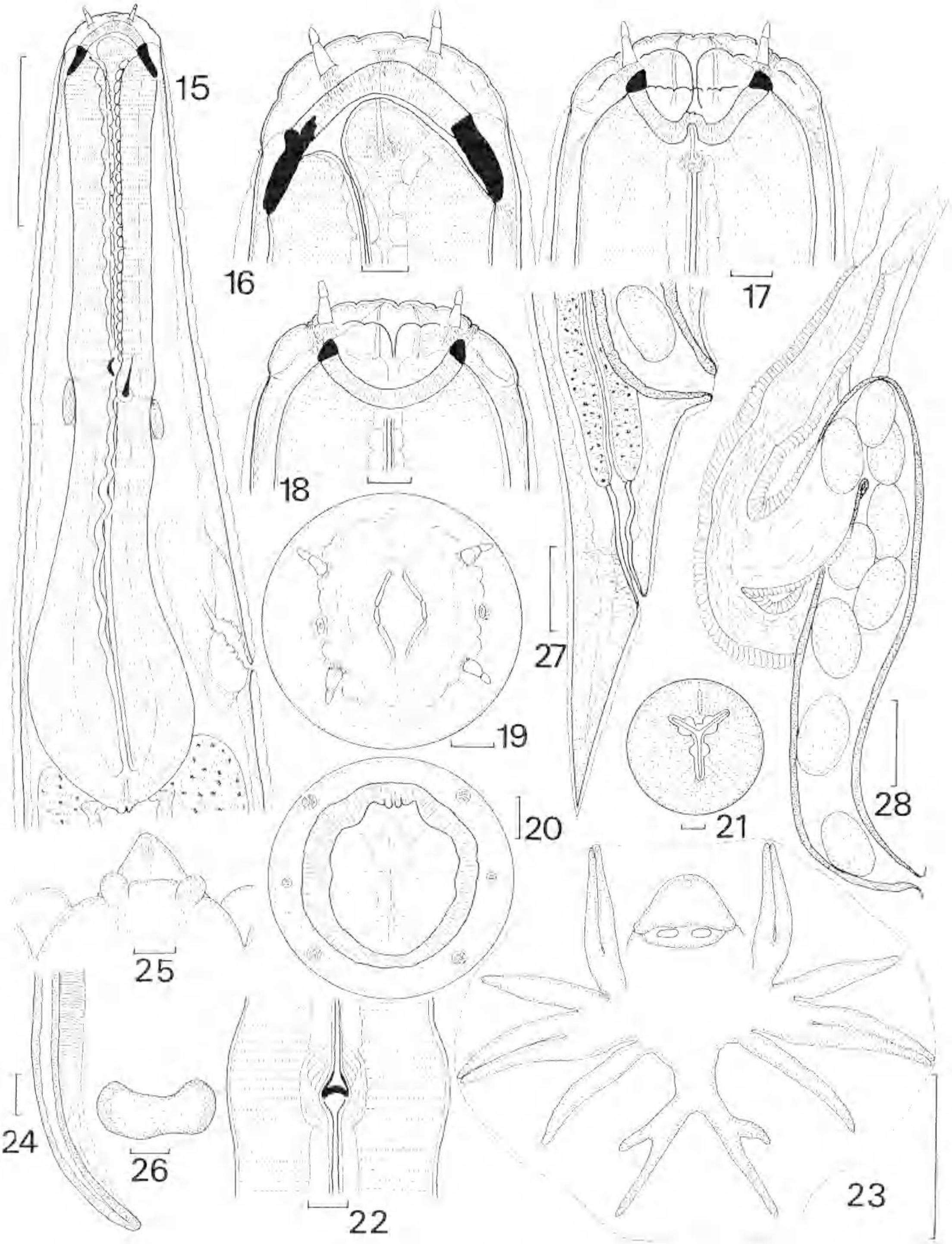
Total length 7.3-9.0 (7.9); maximum width 0.37-0.49 (0.43); buccal capsule 0.006 (0.006) x 0.060-0.070 (0.066); length of oesophagus 0.48-0.56 (0.52); nerve ring to anterior end 0.23-0.27 (0.25); S-E pore to anterior end 0.37-0.47 (0.42); deirid to anterior end 0.15-0.21 (0.18). Tail simple, conical, 0.20-0.30 (0.24) long; vulva close to anus, 0.45-0.63 (0.55) from posterior end; vagina straight, recurrent, 0.71-0.92 (0.80) long; ovejector J-shaped, sphincter and infundibulum short; egg ellipsoidal, 0.08-0.11 (0.10) x 0.06-0.07 (0.06).

Etymology

Laius, son of Labdacus, King of Thebes.

Remarks

Cloacina laius is characterised by a dorsoventrally elongated buccal capsule, six leaf crown elements, a shallow buccal capsule which is arched anteriorly in lateral views, oesophageal bosses extending to the



Figs 15-28. *Cloacina laius* sp. nov. 15. Anterior end, lateral view. 16. Cephalic extremity, lateral view, dorsal aspect on right hand side. 17. Cephalic extremity, dorsal view. 18. Cephalic extremity, ventral view. 19. Cephalic extremity, apical view. 20. Optical transverse section at level of buccal capsule. 21. Optical transverse section through anterior extremity of oesophagus showing thickening of lining. 22. Dorsal oesophageal denticle, dorsal view. 23. Bursa, apical view. 24. Spicule tip, lateral view. 25. Genital cone, dorsal view. 26. Gubernaculum, ventral view. 27. Female tail, lateral view. 28. Vagina and ovejector, lateral view. Scale bars = 0.1 mm, 15, 23, 27, 28; 0.01 mm, 16-22, 24-26.

nerve ring, a single dorsal oesophageal denticle, spicules 1.50-1.97 mm in length and a recurrent vagina. The anteriorly arched buccal capsule immediately distinguishes it from all congeners except *C. circe* sp. nov., described below. Other species with oesophageal bosses, dorsal oesophageal denticles and asymmetrical buccal capsules are *C. eileithyia* Beveridge, 1998 and *C. polyxena* Beveridge, 1998. However, in *C. eileithyia*, the buccal capsule is arched posteriorly in lateral views while in *C. polyxena*, the buccal capsule arches anteriorly only over the dorsal oesophageal tooth and the deviation is seen clearly only in dorsal views. *Cloacina circe* lacks oesophageal bosses and denticles and is therefore immediately distinguishable from *C. laius*. Thus *C. laius* is clearly distinguishable from all congeners.

Cloacina circe sp. nov.
(FIGS 29-39)

Types: Holotype ♂ from stomach of *Setonix brachyurus*, Rottnest Is., WA, coll. I. Beveridge, 17.iv.1982, SAMA AHC 30564, allotype ♀ SAMA AHC 30565; paratypes: 18 ♂♂, 44 ♀♀, SAMA AHC 30566; 1 ♂, 1 ♀, BMNH 1998.9.28.7-8.

Description

Small nematodes; cervical cuticle not inflated in oesophageal region; transverse cuticular annulations prominent. Sub-median papillae 0.014 long, projecting anteriorly from peri-oral cuticle with distal segment curved medially; proximal segment cylindrical, 0.006 long, shorter than ovoid, medially directed distal segment, 0.008 long. Buccal capsule shallow, arcuate in lateral view, with apex of arch lateral. Mouth opening dorsoventrally elongate. Buccal capsule wall thick, dorsoventrally elongated in apical view. Leaf crown elements 6 in number, incurved at tips, arise from full length of internal wall of buccal capsule. Peri-oral cuticle not inflated into lip-like lobes attached to each leaf crown element. Oesophagus simple claviform; dorsal sector of oesophagus protruding into buccal capsule with opening of dorsal oesophageal gland at apex; lining not ornamented with rows of sclerotised bosses; denticles absent in oesophagus. Nerve ring in mid-oesophageal region; deirids in posterior oesophageal region, posterior to nerve ring; S-E pore anterior to oesophago-intestinal junction.

Male (Measurements from 10 specimens, types) (Figs 34-37)

Total length 4.7-7.1 (6.0); maximum width 0.24-0.33 (0.28); buccal capsule 0.018 (0.018) x 0.065-0.090 (0.080), length of oesophagus 0.52-0.62 (0.56); nerve ring to anterior end 0.22-0.27 (0.25); S-E pore to anterior end 0.35-0.42 (0.38); deirid to anterior end 0.34-0.37 (0.36). Bursa without prominent divisions between lobes. Ventral lobes joined ventrally; lateral lobes and ventral lobes joined. Dorsal lobe similar in length to lateral lobes. Dorsal ray divides just before mid-length; secondary division occurs at $^{4}/_{5}$ length; internal branchlets straight, longer than externals, directed posteriorly, almost reaching margin of bursa; external branches short, directed laterally, not reaching margin of bursa. Externodorsal ray arises close to lateral rays, not reaching margin of bursa. Posterolateral and ventrolateral rays fused, reaching margin of bursa; anterolateral ray divergent, shorter than other lateral rays, not reaching margin of bursa; ventrolateral and ventroventral rays fused, reaching margin of bursa. Gubernaculum subtriangular in dorsoventral view, 0.02 (0.02) long; genital cone prominent; anterior lip conical, with single papilla at apex; posterior lip shorter than anterior lip, with pair of dome shaped papillae; pair of lateral inflations of cuticle present on either side of anterior lip; spicules elongate, 0.97-1.35 (1.25) long, alate; alae diminishing gradually in width towards spicule tip.

Female (Measurements of 10 specimens, types) (Figs 38-39)

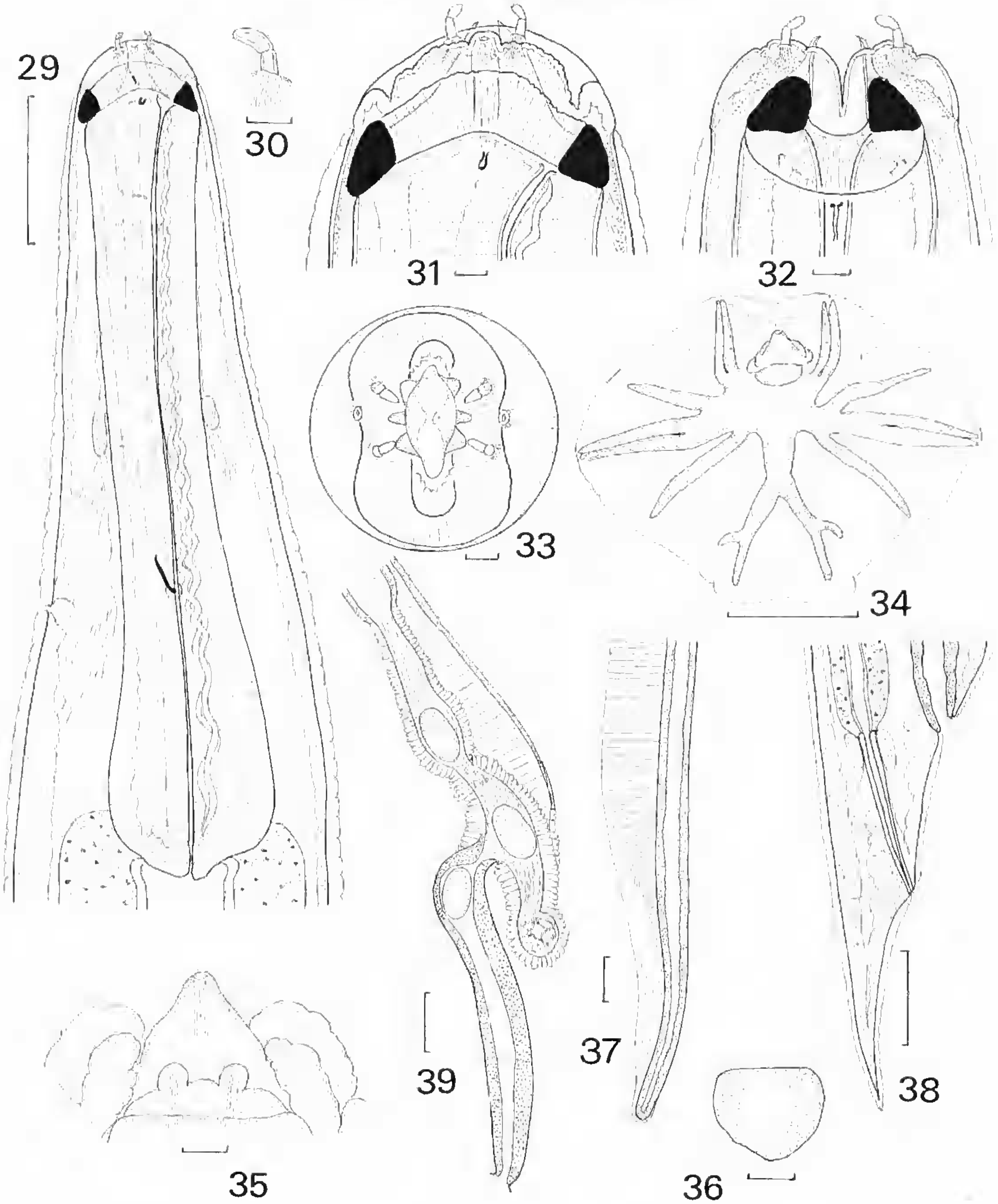
Total length 7.3-10.5 (8.8); maximum width 0.41-0.54 (0.46); buccal capsule 0.018 (0.018) x 0.090-0.098 (0.094); length of oesophagus 0.60-0.72 (0.65); nerve ring to anterior end 0.24-0.30 (0.27); S-E pore to anterior end 0.33-0.46 (0.39); deirid to anterior end 0.30-0.41 (0.34). Tail simple, conical, 0.20-0.26 (0.23) long; vulva close to anus, 0.35-0.51 (0.42) from posterior end; vagina short, straight, 0.32-0.63 (0.48) long; ovejector J-shaped; sphincter and infundibulum short; egg ellipsoidal, 0.08-0.10 (0.09) x 0.05-0.06 (0.05).

Etymology

Circe, daughter of the sun and Perse, famous for her magic.

Remarks

Cloacina circe is characterised by a dorsoventrally elongated mouth opening, six leaf crown elements, cephalic papillae which are situated close together and whose tips are deviated medially, a shallow buccal capsule arched anteriorly, an oesophagus without bosses or denticles, the deirid posterior to the nerve ring, spicules in the range 0.97-1.35 mm and a straight vagina. The anteriorly arched buccal capsule and the dorsoventrally elongate mouth opening distinguish this species from all congeners except *C. laius*. *Cloacina circe* differs from *C. laius* in lacking oesophageal bosses and denticles, in



Figs 29-39. *Cloacina circe* sp. nov. 29. Anterior end, lateral view. 30. Cephalic papilla. 31. Cephalic extremity, lateral view, dorsal aspect on right hand side. 32. Cephalic extremity, dorsal view. 33. Cephalic extremity, apical view. 34. Bursa, apical view. 35. Genital cone, dorsal view. 36. Gubernaculum, ventral view. 37. Spicule tip, lateral view. 38. Female tail, lateral view. 39. Vagina and ovejector, lateral view. Scale bars = 0.1 mm, 29, 34, 38, 39; 0.01 mm, 30-33, 35-37.

having the deirid posterior to the nerve ring rather than immediately anterior to it, in having a straight vagina and in having shorter spicules.

Cloacina chiron sp. nov.
(FIGS 40-51)

Types: Holotype ♂ from stomach of *Setonix brachyurus*, Rottnest Is., WA, coll. I. Beveridge, 17.iv.1982, SAMA AHC 30561, allotype ♀ SAMA AHC 30562; paratypes: 10 ♂♂, 12 ♀♀, SAMA AHC 30563; 1 ♂, 1 ♀, BMNH 1998.9.28.5-6.

Description

Small nematodes; cervical cuticle inflated to level of nerve ring; transverse cuticular annulations prominent. Sub-median papillae 0.016 long, projecting anteriorly from peri-oral cuticle; proximal segment cylindrical, 0.003 long, much shorter than obovoid distal segment, 0.013 long. Mouth opening dorsoventrally elongate. Buccal capsule shallow, symmetrical in lateral and dorsoventral views. Buccal capsule walls circular in apical view. Leaf crown elements 6 in number, with prominent striations, arising from full length of internal wall of buccal capsule. Peri-oral cuticle not inflated into lip-like lobes attached to each leaf crown element. Oesophagus simple claviform; lining not ornamented with rows of sclerotised bosses; denticles absent in oesophagus. Nerve ring in mid-oesophageal region; deirids in anterior oesophageal region, anterior to nerve ring; S-E pore posterior to oesophago-intestinal junction.

Male (Measurements from 10 specimens, types)
(Figs 46-49)

Total length 5.4-9.9 (8.5); maximum width 0.34-0.42 (0.38); buccal capsule 0.015-0.025 (0.020) x 0.065-0.085 (0.079); length of oesophagus 0.59-0.71 (0.67); nerve ring from anterior end 0.30-0.36 (0.34); S-E pore from anterior end 0.79-1.11 (0.97); deirid from anterior end 0.14-0.18 (0.17). Bursa without prominent divisions between lobes. Ventral lobes joined ventrally; lateral lobes and ventral lobes joined. Dorsal lobe slightly longer than lateral lobes. Dorsal ray long, dividing at mid-length; secondary subdivision near extremity; internal branchlets short, slightly longer than externals, directed posteriorly, almost reaching margin of bursa; internal branchlets very short, directed posterolaterally, not reaching margin of bursa. Externodorsal ray arises close to lateral rays, not reaching margin of bursa. Posterolateral and ventrolateral rays fused, reaching margin of bursa; anterolateral ray divergent, shorter than other lateral rays; not reaching margin of bursa; ventrolateral and ventroventral rays fused, reaching margin of bursa. Gubernaculum quadrangular in dorsoventral view, 0.03 long; genital cone prominent; anterior lip conical, with single papilla at apex; posterior lip shorter than anterior lip, with pair of dome-shaped papillae; pair of lateral inflations of cuticle present on either side of anterior lip; spicules elongate, short, 0.58-0.65 (0.62) long, alate; ala terminating anterior to spicule tip.

Female (Measurements of 10 specimens, types)
(Figs 50-51)

Total length 8.5-12.3 (10.5); maximum width 0.46-0.57 (0.50); buccal capsule 0.015-0.020 (0.020) x 0.085-0.095 (0.090); length of oesophagus 0.70-0.78 (0.75); nerve ring to anterior end 0.32-0.40 (0.37); S-E pore to anterior end 0.88-1.17 (1.00); deirid to anterior end 0.12-0.20 (0.16). Tail simple, conical, 0.13-0.20 (0.17) long; vulva close to anus, 0.26-0.38 (0.34) from posterior end; vagina short, straight 0.29-0.38 (0.34); ovejector J-shaped; sphincter and infundibulum short; egg ellipsoidal, 0.10-0.13 (0.11) x 0.06-0.07 (0.07).

Etymology

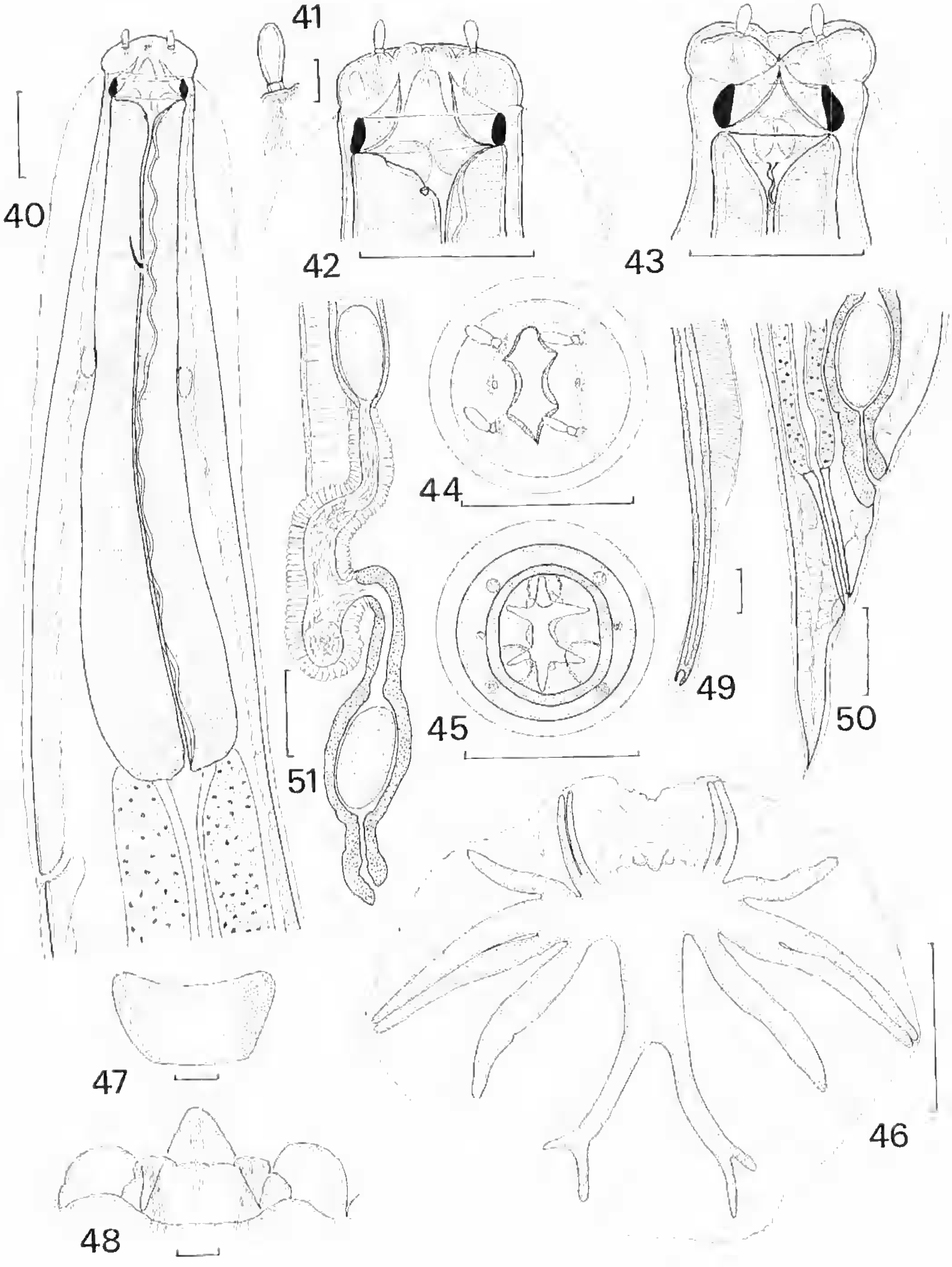
Chiron, centaur, son of Saturn.

Remarks

Cloacina chiron is characterised by a cervical cuticular inflation, cephalic papillae with a long, obtuse distal segment, six leaf crown elements, a symmetrical buccal capsule, a simple oesophagus without denticles or bosses, spicules in the range 0.58-0.65 mm and a straight vagina. The shape of the cephalic papillae and the lack of oesophageal bosses distinguish this species from all congeners except *C. dryope*, *C. hebe*, *C. hypsipyle*, *C. linstowi*, *C. maia* and *C. thetidis*. *Cloacina chiron* is distinguished from *C. dryope* in having a deeper buccal capsule, in not having the anterior region of the oesophagus distinctly broader than the posterior part and in having much shorter spicules (>1.75 mm in *C. dryope*), from *C. hebe* and *C. thetidis* in having a deeper buccal capsule in which the anterior margin does not have anterior lobes in the submedian and ventral positions and from *C. hypsipyle*, *C. linstowi* and *C. maia* in having a shallower buccal capsule without the undulating anterior margin present in the latter two species. In addition, the spicules of *C. chiron* are shorter than those in all of the species listed.

Cloacina cadmus sp. nov.
(FIGS 52-62)

Types: Holotype ♂ from stomach of *Setonix brachyurus*, Rottnest Is., WA, coll. I. Beveridge, 17.iv.1982, SAMA AHC 30555, allotype ♀ SAMA AHC 30556; paratypes: 4 ♂♂, 23 ♀♀, SAMA AHC 30557, 1 ♂, 1 ♀, BMNH 1998.9.28.1-2.



Figs 40-51. *Cloacina chiron* sp. nov. 40. Anterior end, lateral view. 41. Cephalic papilla. 42. Cephalic extremity, lateral view, dorsal aspect on right hand side. 43. Cephalic extremity, dorsal view. 44. Cephalic extremity, apical view. 45. Optical transverse section through buccal capsule. 46. Bursa, apical view. 47. Gubernaculum, ventral view. 48. Genital cone, dorsal view. 49. Spicule tip, lateral view. 50. Female tail, lateral view. 51. Vagina and ovejector, lateral view. Scale bars = 0.1 mm, 40, 42-46, 50, 51; 0.01 mm, 41, 47-49.

Description

Very small nematodes: cervical cuticle not inflated in oesophageal region; transverse cuticular annulations prominent. Sub-median papillae 0.010 long, projecting anteriorly from peri-oral cuticle; proximal segment cylindrical, 0.007 long, longer than ovoid distal segment, 0.003 long. Mouth opening circular in apical view. Buccal capsule shallow, symmetrical in lateral and dorsoventral views. Buccal capsule walls hexagonal in apical view. Leaf crown elements 6 in number, incurved at tip, arising from full length of internal wall of buccal capsule. Peri-oral cuticle not inflated into lip-like lobes attached to each leaf crown element. Oesophagus simple, claviform, slender; lining not ornamented with rows of sclerotised bosses; denticles absent in oesophagus. Prominent dorsal oesophageal tooth projecting from dorsal sector of oesophagus into buccal capsule. Nerve ring in posterior oesophageal region; deirids in posterior oesophageal region, posterior to nerve ring; S-E pore in region of oesophago-intestinal junction.

Male (Measurements from 7 specimens, types) (Figs 57-60)

Total length 3.4-4.7 (4.1); maximum width 0.15-0.19 (0.17); buccal capsule 0.005 (0.005) x 0.018-0.020 (0.019); length of oesophagus 0.32-0.38 (0.34); nerve ring to anterior end 0.15-0.18 (0.16); S-E pore to anterior end 0.26-0.31 (0.28); deirid to anterior end 0.20-0.21 (0.21). Bursa without prominent divisions between lobes. Ventral lobes joined ventrally; lateral lobes and ventral lobes joined. Dorsal lobe slightly longer than lateral lobes. Dorsal ray slender at origin, dividing at mid-length; secondary subdivision occurring at ²/₃ length; internal branchlets longer than externals, directed posteriorly, almost reaching margin of bursa; external branchlets shorter, directed laterally, not reaching margin of bursa. Externodorsal ray arises close to lateral rays, not reaching margin of bursa. Posterolateral and ventrolateral rays fused, reaching margin of bursa; anterolateral ray divergent, shorter than other lateral rays; not reaching margin of bursa; ventrolateral and ventroventral rays fused, reaching margin of bursa. Gubernaculum ovoid in dorso-ventral view, 0.015 (0.015) long; genital cone prominent; anterior lip conical, with single papilla at apex; posterior lip shorter than anterior lip, with pair of dome shaped papillae; pair of lateral inflations of cuticle present on either side of anterior lip; spicules elongate, 1.31-1.46 (1.40) long, alate; spicule tip bifurcate, surrounded by ovoid flange; ala terminating abruptly immediately anterior to spicule tip.

Female (Measurements of 10 specimens, types) (Figs 61-62)

Total length 3.9-5.3 (4.6); maximum width 0.15-0.26 (0.21); buccal capsule 0.005 (0.005) x 0.018-0.020 (0.019); length of oesophagus 0.34-0.41 (0.37); nerve ring to anterior end 0.15-0.18 (0.17); S-E pore to anterior end 0.25-0.37 (0.29); deirid to anterior end 0.17-0.25 (0.19). Tail simple, conical, 0.11-0.18 (0.16) long; vulva close to anus, 0.23-0.30 (0.27) from posterior end; vagina elongate, straight, 0.72-1.00 (0.79) long; ovejector J-shaped; sphincter and infundibulum short; egg ellipsoidal, 0.07-0.09 (0.08) x 0.04-0.05 (0.05).

Etymology

Cadmus, son of the Phoenician king, Agenor.

Remarks

Cloacina cadmus most closely resembles *C. burnettiana* Johnston & Mawson, 1939 in its small size, simple slender oesophagus lacking bosses or denticles, small, symmetrical buccal capsule, cephalic papillae with the proximal segment longer than the distal, six leaf crown elements, spicules in the range 1.31-1.46 mm and a straight vagina. *Cloacina cadmus* differs from *C. burnettiana* in having the deirid posterior to the nerve ring and longer spicules (0.60-0.70 mm in *C. burnettiana*). *Cloacina cadmus* also resembles *C. caballeroi* Mawson, 1977, *C. enyo* Beveridge, 1998 and *C. ips* Beveridge, 1998 but they differ in having the secondary branchlets of the dorsal ray arising at or before the primary bifurcation rather than after it as in *C. cadmus*. Other similar species are *C. nike* Beveridge, 1998 and *C. digitata* Johnston & Mawson, 1940 which differ in having the deirid anterior to the nerve ring and longer spicules (>2.5 mm), *C. cybele* Beveridge, 1998 which differs in having the deirid anterior to the nerve ring and a characteristically enlarged spicule tip, and *C. pearsoni* Mawson, 1971 which has the deirid anterior to the nerve ring and a shorter vagina.

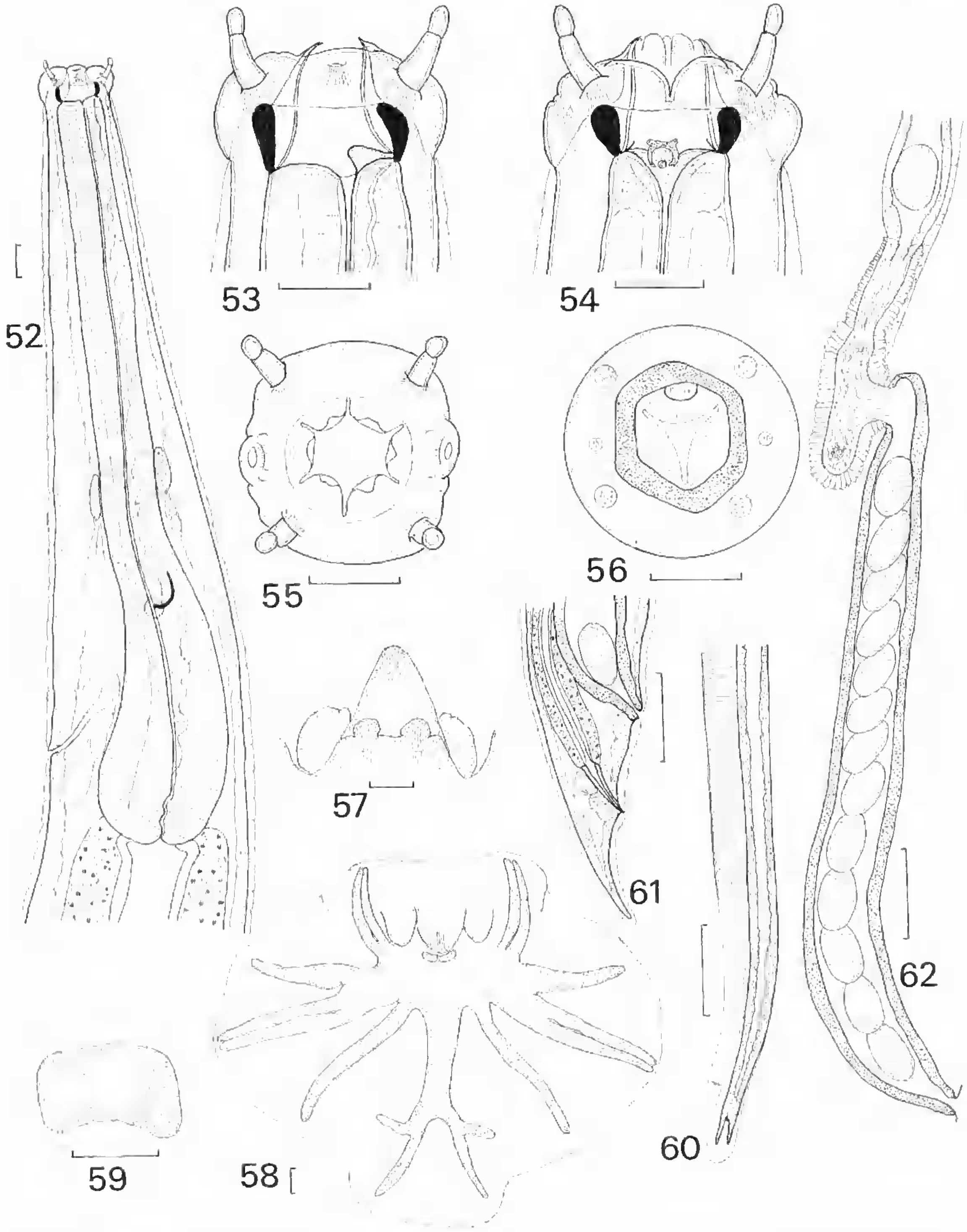
Cloacina telemachus sp. nov.

(FIGS 63-72)

Types: Holotype ♂ from stomach of *Setonix brachyurus*, Rottnest Is., WA, coll. I. Beveridge, 17.iv.1982, SAMA AHC 30570, allotype ♀ SAMA AHC 30571, paratypes: 6 ♀♀, SAMA AHC 30572, 1 ♀, BMNH 1998.9.28.23.

Description

Small nematodes: cervical cuticle not inflated in oesophageal region; transverse cuticular annulations prominent. Sub-median papillae 0.015 long, projecting anteriorly from peri-oral cuticle, distal segment deviated medially; proximal segment



Figs 52-62. *Cloacina cadmus* sp. nov. 52. Anterior end, lateral view. 53. Cephalic extremity, lateral view, dorsal aspect on right hand side. 54. Cephalic extremity, dorsal view. 55. Cephalic extremity, apical view. 56. Cephalic extremity, optical transverse section through buccal capsule. 57. Genital cone, dorsal view. 58. Bursa, apical view. 59. Gubernaculum, ventral view. 60. Spicule tip, lateral view. 61. Female tail, lateral view. 62. Vagina and ovejector, lateral view. Scale bars = 0.1 mm, 52, 58, 61, 62; 0.01 mm, 53-57, 59, 60.

cylindrical, 0.006 long, shorter than obovoid, medially directed distal segment, 0.009 long. Mouth opening circular in apical view. Buccal capsule shallow, symmetrical in lateral and dorsoventral views. Buccal capsule walls striated, circular in apical view. Leaf crown elements 6 in number, only slightly incurved at tips, arise from full length of internal wall of buccal capsule. Peri-oral cuticle not inflated into lip-like lobes attached to each leaf crown element. Oesophagus simple, claviform; lining not ornamented with rows of sclerotised bosses; denticles absent in oesophagus. Nerve ring in anterior oesophageal region; deirids in mid-oesophageal region, posterior to nerve ring; S-E pore anterior to oesophago-intestinal junction, immediately posterior to deirid.

Male (Measurements of holotype) (Figs 68-70)

Total length 7.0; maximum width 0.32; buccal capsule 0.010 x 0.057; length of oesophagus 0.65; nerve ring from anterior end 0.27; S-E pore from anterior end 0.47; deirid from anterior end 0.41. Bursa without prominent divisions between lobes. Ventral lobes joined ventrally; lateral lobes and ventral lobes joined. Dorsal lobe similar in length to lateral lobes. Dorsal ray divides at ½ length; secondary subdivision occurs at ⅔ length; internal branchlets long straight, directed posterolaterally, almost reaching margin of bursa; external branchlets very short, directed posterolaterally, not reaching margin of bursa. Externodorsal ray arises close to lateral rays, not reaching margin of bursa. Posterolateral and ventrolateral rays fused, reaching margin of bursa; anterolateral ray divergent, shorter than other lateral rays, not reaching margin of bursa; ventrolateral and ventroventral rays fused, reaching margin of bursa. Gubernaculum quadrangular in shape in dorsoventral view, 0.02 long; genital cone prominent; anterior lip conical, with single papilla at apex; posterior lip shorter than anterior lip, with pair of dome-shaped papillae; spicules elongate, 2.33 long, alate.

Female (Measurements of 9 specimens, types) (Figs 71-72)

Total length 5.9-9.4 (7.1); maximum width 0.36-0.51 (0.44); buccal capsule 0.010-0.015 (0.013) x 0.053-0.060 (0.057); length of oesophagus 0.74-0.80 (0.77); nerve ring to anterior end 0.27-0.30 (0.28), S-E pore to anterior end 0.40-0.49 (0.44); deirid to anterior end 0.36-0.40 (0.38). Tail simple, conical, 0.17-0.27 (0.21) long; vulva close to anus, 0.30-0.41 (0.37) from posterior end; vagina straight, 0.45-1.12 (0.79) long, ovejector J-shaped; sphincter and infundibulum short; egg ellipsoidal, 0.08-0.10 (0.09) x 0.04-0.05 (0.05).

Etymology

Telemachus, son of Ulysess and Penelope.

Remarks

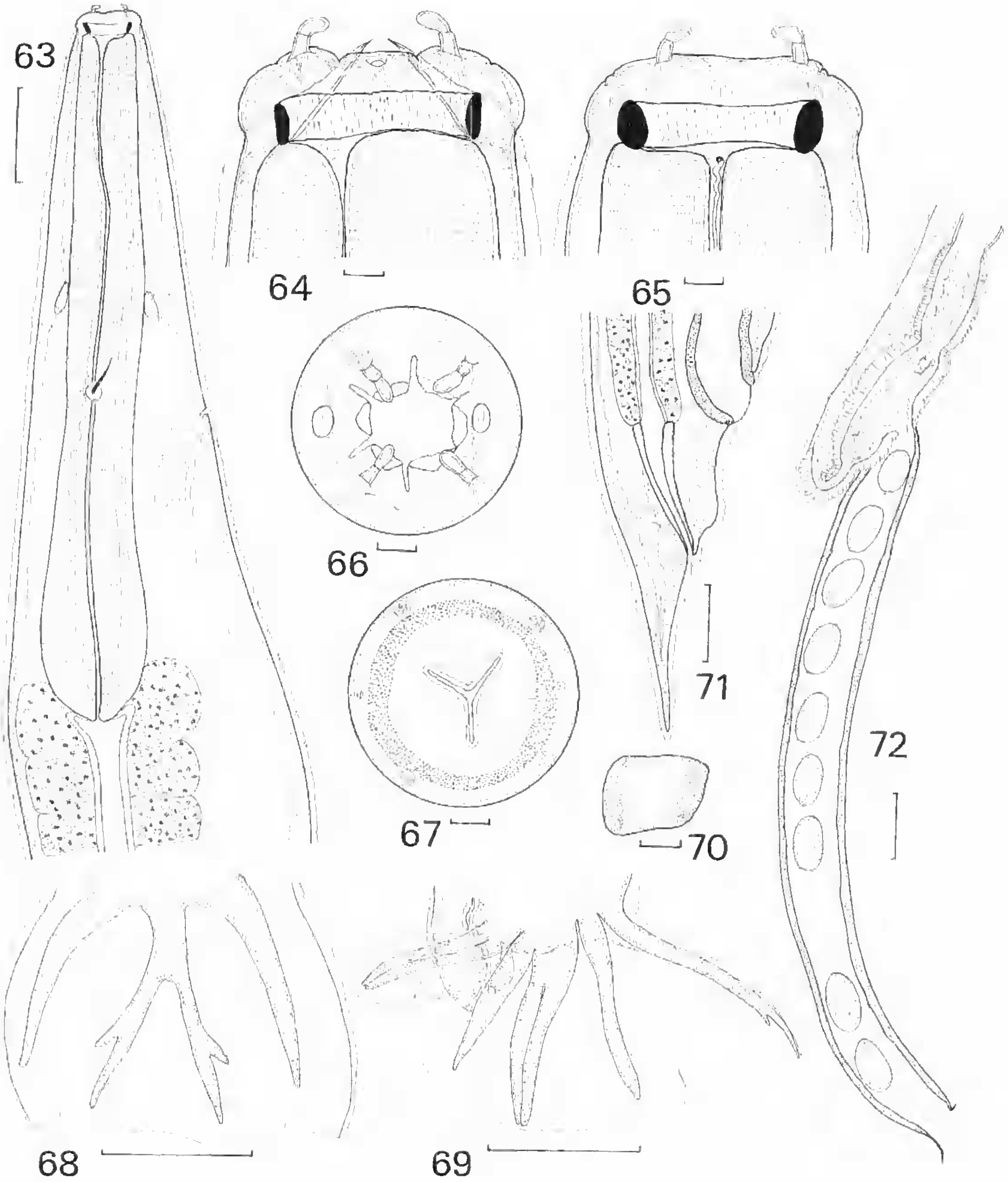
Cloacina telemachus is characterised by the cephalic papillae with the distal segment globose and directed medially, six leaf crown elements, an oesophagus without bosses or denticles, the deirid posterior to the nerve ring, spicules 2.33 mm long and a straight vagina.

Although described from a single male, *C. telemachus* is readily distinguishable from all congeners except *C. daveyi* Mawson, 1977, *C. edwardsi* Mawson, 1972, *C. epona* Beveridge, 1998, *C. ernabella* Johnston & Mawson, 1938, *C. feronia* Beveridge, 1998, *C. frequens* Johnston & Mawson, 1938 and *C. themis* Beveridge, 1998 by the shape of the cephalic papillae with a medially directed, globose distal segment. *Cloacina telemachus* is distinguished from *C. edwardsi* in that it lacks the cervical cuticular inflation and a comb-like ornamentation of the oesophageal lining. The spicules of *C. edwardsi* are shorter (0.41-0.47 mm) and the vagina is very short. *Cloacina telemachus* differs from the remaining members of this group in that it lacks oesophageal denticles. In addition, *C. telemachus* differs from *C. daveyi* which has the deirids at the level of the nerve ring, spicules > 3.6 mm and a recurrent vagina, from *C. epona* which has anterior deirids and spicules 0.96-1.05 mm long, from *C. ernabella* which has anterior deirids and spicules 1.42-1.83 mm long, from *C. feronia* which has anterior deirids and spicules 1.65-1.85 long, from *C. frequens* which has anterior deirids, spicules 1.02-1.10 long and a Y-shaped vagina and from *C. themis* which has anterior deirids and spicules 1.02-1.23 mm long.

Discussion

The current examination of gastric nematodes from a series of quokkas shows that this host, like most other kangaroo and wallaby species, harbours a range of species of *Cloacina* rather than the single species, *C. setonicis*, described to date. The new material came from a small number of quokkas collected at a single location and it is likely that more extensive examinations of this host will reveal additional species of *Cloacina*.

All species described from the quokka are currently considered to be restricted to this host. However, the parasite fauna of macropodid marsupials from Western Australia is still very poorly known and the new species of *Cloacina* described here may prove to have a wider host range when more studies are carried out in the region.



Figs 63-72. *Cloacina telemachus* sp. nov. 63. Anterior end, lateral view. 64. Cephalic extremity, lateral view, dorsal aspect on left hand side. 65. Cephalic extremity, dorsal view. 66. Cephalic extremity, apical view. 67. Cephalic extremity, transverse optical section through buccal capsule and anterior oesophagus. 68. Dorsal lobe of bursa, dorsal view. 69. Lateral lobe of bursa, lateral view. 70. Gubernaculum, ventral view. 71. Female tail, lateral view. 72. Vagina and ovejector, lateral view. Scale bars = 0.1 mm, 63, 68, 69, 71, 72; 0.01 mm, 64-67, 70.

Some of the new species closely resemble described taxa while others exhibit novel morphological features within the genus or novel combinations of morphological features. *Cloacina cadmus* closely resembles *C. burnettiana* found in *Macropus dorsalis* in Queensland (Beveridge 1998). Similarly, *C. chiron* possesses obovate cephalic papillae similar to a suite of species (*C. dryope*, *C. hebe*, *C. hypsipyle*, *C. linstowi*) found in *Macropus dorsalis* in Queensland (Beveridge 1998), but differs from all of these possible relatives in the simple shape of the buccal capsule and the oesophageal lobes projecting into the buccal capsule. *Cloacina ceres* has similarly shaped cephalic papillae but has bosses lining the oesophagus, a feature characteristic of an alternative suite of species found in a wide range of macropodid hosts (Beveridge 1998). *Cloacina telemachus* has cephalic papillae resembling *C. themis* found in *Macropus irma* (Jourdan, 1837) from Western Australia, *C. ernabella* from *Petrogale lateralis* Gould, 1842 from central Australia and *C. daveyi*, *C. frequens*, *C. epona* and *C. feronia* all from *Macropus robustus* from inland Australia, but differs from all of them in lacking oesophageal denticles. By contrast, *C. laius* and *C. circe* have an entirely novel, anteriorly arched buccal capsule which occurs in no congener. Therefore, in as far as it is possible to assess relationships within the genus, the series of species of *Cloacina* described from the quokka has possible affinities with suites of species in *M. dorsalis* and *M. robustus*, but the striking morphological originality of most of the new species makes the determination of associations difficult. It does suggest that more extensive examination of parasites from Western Australian macropodids will continue to reveal morphologically novel species of *Cloacina*.

Acknowledgments

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